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MAY - 9 1994
FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF THE SECRETARY

May 9, 1994

EX PARTE OR LATE FILED

HAND DELIVERED

Mr. William F. Caton
Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

RE: Ex Parte Notice - PR Docket No. 93-61, RM-8013

Dear Mr. Caton:

In accordance with Section 1.1200 et. seq. of the Commission's Rules, this is to advise that on May 9, 1994, Jay Padgett, of TIA's Mobile and Personal Communications Consumer Radio Section, and Henry Rivera, attorney for Metricom, Inc., and Southern California Edison Company ("SCE") ;met with Ruth Milkman, of Chairman Hundt's staff, to discuss TIA's, Metricom's and SCE's position in this proceeding as articulated in their various filings in this proceeding. The attachments to this Ex Parte Notice was filed with the Commission and delivered to Ms. Milkman on May 9, 1994.

Sincerely,

Henry M Rivera

Henry M. Rivera

HMR:lmc
Attachment
cc: Ruth Milkman, Esq.

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FEDERAL COMMUNICATIONS COMMISSION
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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Amendment of Part 90	)	PR Docket No. 93-61
of the Commission's Rules	)	RM-8013
to Adopt Regulations	)	
for Automatic Vehicle	)	
Monitoring Systems	)	

COMMENTS OF PACTEL TELETRAC

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March 15, 1994

into a specific receive site.[10] In isolated instances where Part 15 devices do cause interference to LMS systems, problems can often be resolved through power reductions or the use of directional antennas.

To enhance the stability of the Part 15 environment, Teletrac would support a definition for "harmful interference" to be included in the rules. A possible set of criteria would include maximum interference levels relative to ambient noise levels and a maximum duty cycle. Teletrac proposes the following language:

> A Part 15 device will be considered a source of harmful interference if the signal level from that device exceeds the average interference and noise floor at an LMS receiver by more than 10 dB for more than 20% of the time over any 60 second period (10% if the signal exceeds the 10 dB limit at more than one LMS receiver).

In any event, Teletrac's new sharing scheme would further improve the environment for Part 15 devices. Because wideband LMS systems are likely to gravitate to the 902-912 MHz band where they will receive protection from narrowband system interference, Part 15 devices will have greater access to the remaining 16 MHz (and continue to be free to operate anywhere within the entire band on a noninterfering basis as they do now). Part 15 manufacturers can thus design devices to operate above 912 MHz with greater confidence about future usage of the band.

While Teletrac continues to believe concerns raised by the Part 15 community are misplaced, and that most Part 15

[10] *See* Teletrac NPRM Reply Comments at 44.

devices will not cause harmful interference to wideband systems, the new proposal should alleviate fears about coexistence in the 902-928 MHz spectrum.

B. Feasibility of Teletrac's Sharing Proposal. As pointed out by MobileVision in its *ex parte* filing, Teletrac's sharing proposal is a significant departure from its previous recommendations that wideband systems not share spectrum.[11] Teletrac's new proposal does not contradict its past technical analyses, but rather provides a compromise solution with the minimum rules necessary for successful commercial operation of two wideband LMS systems.

Teletrac has consistently maintained that uncontrolled sharing of spectrum would not be workable. Teletrac's position has not changed; rather, it has devised sharing rules that work by allowing sharing of the return link only, segregating forward link transmissions, and alternating housekeeping transmissions of co-channel systems.

Teletrac has maintained that two wideband LMS systems will interfere with one another if they attempt to share

---

[11] MobileVision *ex parte* at 5. MobileVision's comments regarding the alleged anticompetitive impact of Teletrac's proposal are inaccurate. In addition to the two wideband systems eligible for co-channel protection, additional wideband systems can provide services in the 902-912 MHz band on a noninterfering basis, and in the 912-928 MHz band on a co-primary basis. Furthermore, MobileVision's current investment in infrastructure in the upper frequencies can be protected through grandfathering or transitional rules.

Interference Analysis of Part 15 Devices and LMS Wideband Systems

INITIAL CALCULATIONS

G K Smith

March 8th, 1994

DRAFT

METS, Inc.

5.2. Indoor Part 15 device desensitizing the LMS fixed site receiver.

If the transmitted power of the indoor Part 15 radio is 1W, (30dBm), then due to the 10 dB loss though the building wall, the effective radiated power can be considered as 20dBm. The required distances of the Part 15 radio from the LMS fixed site, for 0, 10 and 20 dB desensitization ("Threshold" -102, -92 and -82 dBm respectively), can be calculated. Table 2 shows the results:

Table 2 - Indoor Pt 15 radio interference distances

Using Egli formula

(assuming 9dBi antenna at fixed site)

Threshold	**-102**	-102	-102	**-102**	-102	dBm
Pt (ERP)=	**20**	10	0	**-10**	-20	dBm
hb=	**200**	200	200	**200**	200	ft
hm=	**6**	6	6	**6**	6	ft
R=	**2.89**	1.62	0.91	**0.51**	0.29	miles
Threshold	**-92**	-92	-92	**-92**	-92	dBm
Pt (ERP)=	**20**	10	0	**-10**	-20	dBm
hb=	**200**	200	200	**200**	200	ft
hm=	**6**	6	6	**6**	6	ft
R=	**1.62**	0.91	0.51	**0.29**	0.16	miles
Threshold	**-82**	-82	-82	**-82**	-82	dBm
Pt (ERP)=	**20**	10	0	**-10**	-20	dBm
hb=	**200**	200	200	**200**	200	ft
hm=	**6**	6	6	**6**	6	ft
R=	**0.91**	0.51	0.29	**0.16**	0.09	miles

If the indoor device is transmitting 1W (Section 15.247), within the bandwidth of the spread spectrum signal, 20 dB desensitization of the fixed site is possible if the indoor Part 15 radio is within 0.9 mile of the site. If the device is transmitting 1mW (Section 15.249), then it needs to be much closer, 0.16 mile, to desensitize the fixed site by 20 dB.

The figures in Table 2 are worst case calculations and, other losses, such as antenna efficiency and blocking, could be present. However, the clear conclusion is that indoor Part 15.247 radios could cause a 10 to 20 dB desensitization of the LMS fixed site if they are within 1 mile of the LMS site.

Summary

Required distance of indoor Part 15 from LMS fixed site for 0, 10 and 20 dB desensitization.			
Desensitization	0dB	10dB	20dB
Part 15.247	2.9	1.6	0.9 miles
Part 15.249	0.5	0.3	0.2 miles

These results show that the indoor Part 15.247 devices could cause significant desensitization of LMS fixed sites and reduce the effective range of mobiles to about 6 miles[4]. This represents a significant economic consequence as more fixed sites will need to be installed.

5.3.2. Data and Voice channels

In the MobileVision system, narrow band, 12.5 kHz, channels are also transmitted to and from the mobile. Not all fixed sites transmit these signals, in fact, only about 1 in 3[5].

The maximum transmitted power for a Part 15.247 device is 8 dBm in a 3kHz band, which corresponds approximately to a 500kHz spread bandwidth. 1,2 and 4 MHz bandwidths correspond to 5, 2 and -1 dBm respectively. Therefore in a 12.5 kHz band, the maximum transmitted power (Ptu) is:

Spread	12.5 kHz B/W
500kHz	14 dBm
1 MHz	11 dBm
2 MHz	8 dBm
4 MHz	5 dBm.

For the threshold of blocking:

$$Pru = Prw - S/N \qquad \text{ignoring fade margins.}$$

(S/N is the required output signal to noise ratio)

or $$40 \log dw/du = (Ptw - S/N) - (Ptu - f) + 20 \log hw/hu$$

Table 4 shows the calculated results.

[4]The theoretical range of a mobile transmitting 10W and a receiver with PG = 24 dB, NF = 6 dB, S/No = 10 dB and antenna height 200 feet is 19 miles.
[5]A typical LMS system consists of recieve only sites, for the reception of the location bursts, and transmit/receive sites which also transmit the command and data/voice channels.

5.7. Summary

There is a possibility that indoor Part 15.247 devices, operating within a mile of a wideband LMS fixed site, will desensitize that site by 20dB, effectively reducing its range by a factor of 3.

Indoor Part 15.249 devices would need to be within a third of a mile in order to cause the same effect.

There is negligible interference from an indoor Part 15 radio to the LMS mobiles.

There is a low probability of interference to the indoor Part 15 radio from wideband LMS mobiles.

Indoor Part 15 devices could experience interference from the LMS forward links and narrow band data/voice signals if a transmitting LMS fixed site is within half a mile.

If the operating distance of the indoor Part 15 device is kept short, then the chance of interference is very low, as the operating distance increases, then the chance increases. The near-far-ratio (NFR) figures can be used to quantify this.

The use of correct power levels, related to the distance of the Part 15 link, and the sensible use of diraectional antennas would alleviate most of the problems. In the isolated cases where interference still occured, the Part 15 device could be easily moved to the center of the band.

Summary

Required distance of outdoor Part 15.247 from LMS fixed site for 0, 10 and 20 dB desensitization.			
Desensitization	0dB	10dB	20dB
No antenna directivity	11.5	6.5	3.6 miles
-20dB antenna directivity	3.6	2.0	1.2 miles

Any outdoor Part 15 device, within 3.6 miles of an LMS receiving site could desensitize that site by 20 dB. This is very significant interference and is potentially disasterous for the LMS system. The use of directional antennas by the outdoor device could improve the situation but, even if the signal was reduced by 20 dB in the direction of the LMS fixed site, over a mile separation is still required.

6.6. Summary

There could be significant blocking of an LMS fixed site by an outdoor Part 15 radio if it is transmitting 1W in the LMS band. With 20 dB less power, the outdoor Part 15 radio needs to be over a mile away from the fixed site to avoid interference.

An LMS mobile within about a quarter mile of an outdoor Part 15 1W transmitter will be unable to receive narrow band data or voice.

There is a very good possibility of an LMS mobile interfering with the reception of an outdoor Part 15 radio, depending on the Part 15 link distance. For a link distance of 1 mile, a mobile within 0.8 miles has the potential to interfere.

An LMS transmitting site will severely interfere with the outdoor Part 15 link.

The outdoor Part 15 radios and the LMS system are liaible to interefere with each other, and therefore in those cases it is probable that the outdoor Part 15 devices will be set to the center of the band. This is further discussed in section 8.

Setting the power level compatible with the distance of the link and the use od directional antennas could alleviate some of the problem.

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REPLY COMMENTS OF PACTEL TELETRAC

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March 29, 1994

valuable tracking applications for which this spectrum has been allocated for 20 years, while at the same time addressing the concerns of other users of the band who also provide products and services to the public.[7] We believe our approach is equitable, reasonable, and pro-competitive.

II. Part 15 Concerns

Part 15 manufacturers and users in the 902-928 MHz band continue to seek a reversal of the fundamental relationship between licensed and unlicensed services which the Commission has set in place: unlicensed Part 15 devices must not interfere with licensed services. The same Commission order, quoted by many parties as encouraging the development of Part 15 devices, made clear that such development must always be subject to the "basic precept of the Part 15 rules that non-licensed operations are not to cause harmful interference to established services."[8]

The choice is not between the Commission either moving LMS systems to another band or deciding it "does not care about Part 15 consumers."[9] Nor is the issue one of deciding which industry, Part 15 or wideband LMS, is of importance to

---

7 Teletrac designation of spectrum from 902.5-912 MHz for wideband LMS system retains the Commission's original allocation from 904-912 MHz for wideband operations. Teletrac's current system has tens of thousands of units in use, with tens of thousands more in production for its currently available services. No justification has been put forth for stranding these consumers by shifting wideband LMS systems to any other portion of the 902-928 MHz band.

8 In the Matter of Amendment of Parts 2 and 15 of the Rules with regard to the operation of spread spectrum systems, 5 FCC Rcd 4123 (1990) at Para. 8.

9 See e.g., ADEMCO Comments at 12.

our economy.[10] The issue is how to accommodate multiple providers and users of various valuable services in this spectrum.

As Teletrac has stated repeatedly, its wideband LMS system has not suffered deleterious effects due to interference from Part 15 devices except in isolated cases.[11] LMS systems employ spread spectrum techniques which are tolerant of Part 15 interference. The processing gain used by LMS systems (on the order of 15 DB or more) in the return link (mobile-to-base-station link) protects mobile transmissions from signals of limited power such as those from Part 15 devices. However, the near-far effects associated with radio link sharing can at times overcome the benefits of even high processing gain. Therefore, Teletrac and other wideband LMS systems employ techniques such as receiver site redundancy and retry protocols to further enhance their tolerance to interference.

Numerous parties referenced NTIA's recent estimate that more than two million Part 15 devices already occupy the 902-928 MHz frequency band today.[12] Teletrac systems currently serve approximately 15% of the continental U.S.

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10 See Metricom Comments at 16.

11 Teletrac NPRM Reply Comments at 42-46. ADEMCO argues that because Teletrac claims interference from Part 15 will be isolated, Part 15 should be elevated to co-primary status with licensed services. ADEMCO Comments at 13. While the number of problems will be small, there is no basis for completely invalidating the Commission's Part 15 policies which require Part 15 devices to prevent interference to licensed services.

12 See, e.g., Metricom Comments at 8; ADEMCO Comments at 10.

population, which would imply that over 300,000 Part 15 devices are currently operating in harmony with Teletrac today.[13] Yet, there have been fewer than 60 instances nationwide in which there have been any signs of a problem, indicating that in well over 99% of the time, interference is not occurring. Where there is a problem, in many instances it can be alleviated by minor adjustments to the Part 15 device which do not affect its operation.[14] Additionally, Teletrac proposed in its March 15, 1994 filing a definition of harmful interference that would protect Part 15 users from spurious complaints.[15]

Because of its extensive real world experience in coexisting with Part 15 devices, Teletrac does not believe vaguely described "tests" to measure interference between

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[13] This is a conservative assumption given that Part 15 devices are heavily used in metropolitan areas such as those where Teletrac is operating.

[14] See Mobilevison Comments at Annex 2, pg. 42, recommending that installation manuals for Part 15 devices include section on power levels and correct use of directional antennas. Additionally, simple changes to shift the frequency are also possible and in many cases the Part 15 devices are designed to operate on one of several frequencies.

[15] Teletrac's proposed definition was as follows: "A Part 15 device will be considered a source of harmful interference if the signal level from that device exceeds the average interference and noise floor at an LMS receiver by more than 10 dB for more than 20% of the time over any 60 second period (10% if the signal exceeds the 10 dB limit at more than one LMS receiver)." Teletrac Comments at 10.

LMS and Part 15 devices would be fruitful.[16] "Testing" would in fact be an open-ended means of prolonging this rulemaking indefinitely, with an unlimited number of devices and scenarios to be tested.[17] Resources from both industries would be better spent working cooperatively on solutions for those limited cases where interference occurs -- and that cooperation can take place in the context of the rule Teletrac proposes. Given the clear public interest in LMS systems, Part 15 users cannot object to rules needed to clarify how LMS can proceed simply on the basis of speculation that interference will occur.[18]

Several Part 15 parties argue that they will be worse off under Teletrac's new proposal.[19] Clearly, this is not

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[16] See TIA Comments at 7. Through letters and telephone calls with Dr. Padgett from TIA, Teletrac expressed its view that its system will be able to operate with noise levels equal to or above those where Part 15 devices will start to adversely interfere with each other. Teletrac proposed an interference simulation process based on statistical models, and has provided the information needed on the performance of its receivers, power levels, signaling schemes and locations of its sites. The models for RF propagation in urban and suburban environments are well known and documented in the literature. The remaining inputs (i.e., characteristics, quantities, and usage of Part 15 devices) are available from the Part 15 community themselves.

[17] Although interference is measurable at the single receiver level, this measurement is not a direct indication of system performance degradation, given other design aspects such as link margin, number of sites, location of sites, and retry protocols.

[18] ADEMCO cites Dr. Padgett in concluding that "Part 15 devices in 902-928 MHz band pose a serious interference threat to wideband pulse-ranging AVM system's such as Teletrac's." ADEMCO Comments at 7. In fact, in his "Analysis of Teletrac Receiver Performance and Part 15 Interference", October 21, 1993, at 14, Dr. Padgett says that his conclusions imply that there may be interference problems. Teletrac's real world operations in six major cities show everyday that its LMS system has been properly designed for its environment.

[19] ADEMCO Comments at 10; Metricom Comments at 13.

C. Z. Czerner
Vice President, Corporate Development
PacTel Teletrac™
9800 La Cienega Blvd., Suite 800
Inglewood, CA 90301-4420

October 28, 1993

Dear CZ,

As you may know, several of us from TIA and EIA met on October 22 with FCC/PRB Chief Ralph Haller to discuss the potential for interference from Part 15 devices in the 902-928 MHz band to disrupt the operation of Teletrac's receivers. We provided Mr. Haller with the enclosed paper, which documents the analysis and conclusions. You may recognize some of this material, which we discussed with yourself and Yair Karmi during our October 5 meeting.

Mr. Haller suggested that the Part 15 industry conduct experiments in cooperation with Teletrac, to explore the effect of interference from Part 15 devices on your system. To do so without undertaking a massive experimental program, we probably should isolate a single Teletrac receive site and configure your equipment in such a way that we can quantify the error in the time-of-arrival (TOA) estimate generated by the receiver. We should choose a site that offers the best potential for a controlled variation of interference source positioning.

Since the TOA estimation error is a statistical quantity, we will need to record a large number of samples for each desired set of test conditions to obtain statistically valid results. We therefore will need a test control system that will repeatedly query a vehicle, causing it to generate many samples (e.g., 1000-5000) of the reverse-link burst. The system also should create a record of the received power level associated with the desired signal. We then will have a test bed for investigating the effect on receiver performance of different power levels, modulation formats, receiver/interference source separation distances, etc.

In the interest of having access to interference sources that represent the Part 15 industry as a whole, I have contacted Steve Schear, Chairman of the Part 15 Coalition, and he has agreed on behalf of his constituents to support the experiment. If you believe that this endeavor would be practical and worthwhile, we should jointly develop a detailed test plan. Please let me know whether you are interested in pursuing this.

Regards,

Jay E. Padgett
Chairman, TIA Mobile & Personal Communications
Consumer Radio Section

cc: (w/o enclosure)

R. A. Haller - FCC/PRB
E. J. Schimmel - TIA

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PAC TEL TELETRAC℠
A Pacific Telesis Company

Cynthia (CZ) Czerner
Vice President
Corporate Development

November 23, 1993

Mr. Jay Padgett
Chairman, TIA Mobile & Personal Communications
Consumer Radio Section
Fax: (908) 834-1836

Dear Jay:

This letter responds to your letter dated October 28, 1993. I apologize to you for my tardy response. As I mentioned to you by telephone, the delay was caused by my responsibility for business planning, which has consumed all of my time for the last month. Unfortunately, we only have limited resources at Teletrac. I go to sleep at nights dreaming of hiring a big staff!!!

Jay, I need to say at the outset that I was extremely surprised to read your letter for a number of reasons. After Yair and I met with your section at the TIA, I called you to inquire as to whether there were any next steps, and whether you wanted us to test our theory that cordless telephones and Teletrac can live in harmony. You said that you were having a full section meeting, and would contact me after that had occurred. Therefore, you might understand my surprise to receive a letter that stated that you went to the FCC's Private Radio Bureau with a paper showing your theory that we cannot share.

Your paper contains some basic inaccuracies that led you to wrong conclusions. Our engineers have itemized a few of the key points, which we would be happy to sit down and discuss with you in greater detail. These points are as follows:

- The Teletrac system has built-in redundancy. Temporary interference at any level to a few sites does not prevent it from servicing customers.

- The scenario used for the analysis is unrealistic. You create a scenario in which Part 15 devices themselves would not be able to operate. If Part 15 devices start transmitting high energy in line-of-sight from our sites, they would also be in line-of-sight of each other, and at significantly shorter ranges. Since these low cost devices have poor frequency discrimination, the compound effect of in-band interference and adjacent channel interference would prevent all of them from operating. Thus, frequency hopping devices like your cordless phones would find their synchronization frequencies jammed, and they would not be able to initiate communication; or, if they succeeded in synchronizing, more of their frequencies would be interfered with by other devices and the error rate would exceed any error correction threshold. Therefore communication would be lost. Direct sequence spread spectrum devices would find that even a few line-of-sight emissions from other Part 15 devices would raise their perceived noise level to above what their limited processing gain can cope with, and communication would be lost.

• The assumption that a receiver threshold is the limiting factor in TOA measurement is wrong. Unlike radars, well designed terrestrial radiolocation receivers do not require detection thresholds. The determination of the range in which a radiolocation receiver has to provide TOA readings is a system design parameter. The receiver is optimized for the range where its readings are valid. There is no technological limitation in providing readings in a system with twice the Gabor bandwidth and one quarter the total energy (i.e. 1/4 the power-time product), allowing for a fourfold increase in capacity for the same transmitted power.

These are just some of the major points. There are others. Again, let me stress that we would be happy to sit down and talk with you regarding your submission. It is unfortunate that Yair and I were not shown your paper in advance of the submission to the FCC because I think that many of these concerns could have been resolved without misleading the Commission.

Let me also repeat our offer to test whether cordless telephones and Teletrac can live in harmony and our commitment to move forward quickly with the test. We are not willing, however, as you suggested, to have a test that includes every type of Part 15 device that is either on the market or in development. Just getting everyone involved to agree on the test scenarios would take over a year. The test itself would probably take at least another year. We do not have the time nor resources to devote to such a test, and the public interest would not be served by such a delay. We have a living test that has gone on for years, and that is a real life test of existing in the same spectrum with Part 15 devices. It is a rare occurrence that we have a problem with a Part 15 device.

If you continue to be interested in testing cordless telephones and the Teletrac system, please give me or Yair a call. We believe that we can agree on a test and execute it within the next two months. Please bear in mind, however, that you will have to disclose some information that you might regard as proprietary in order to accomplish the test. We, however, would be pleased to sign a confidentiality agreement with you, and assume that you will do the same with respect to Teletrac's proprietary information.

Yair and I look forward to working with you.

Yours truly,

Cynthia S. Czerner
Vice President

cc: R.A. Haller- Chief, FCC/PRB
E. J. Schimmel - TIA

Kathleen Abernathy
Yair Karmi

November 24, 1993

Cynthia S. Czerner
Vice President, Corporate Development
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Dear CZ,

This is in response to your letter of yesterday (enclosed). I will address the issues you raised about the interference analysis, and then discuss interference field testing, in which we continue to have an interest. First, however, there are some points in your second paragraph that warrant a response. You express surprise upon learning of our 10/22 visit to the Commission following our 10/19 Section meeting, and our sharing of the interference analysis with Mr. Haller. Given the short time between the Section meeting and the FCC visit, I saw no point in contacting you until after we had received some feedback from Mr. Haller, since we had already shared with you the substance of the analysis during our meeting at TIA October 5. We felt that Mr. Haller should have the benefit of a similar discussion. Your statement that we are "misleading the Commission" with this information (p. 2 of your letter) is unfounded, as discussed in detail below.

The following comments address point by point the issues you raised about the interference analysis.

- You point out that the Teletrac system has redundancy; I assume you mean redundancy in site deployment, plus retry capability (i.e., time diversity). Obviously, such measures will in general protect the system against sporadic, occasional interference. However, when the interference becomes chronic and widespread, its effect on the performance of your system can take several forms. Interference to a given site that is more or less continuous can essentially remove that site from service. If this occurs at several sites, there may be locations in which vehicles can no longer be located. Interference that occurs with some fractional duty cycle (such as from a single frequency hopper) will clearly reduce the throughput of the affected site due to the need to retransmit, thereby reducing the system capacity. It seems to me that this possibility cannot be dismissed. As discussed in the paper, the severity of the problem increases as the number of frequency hoppers increases.

- You suggest that interference among Part 15 devices themselves would tend to limit their deployment density, and hence their ability to pose a threat to your system. This is untrue for two reasons. First, it is possible, and even likely, that two Part 15 devices can have a clear line-of-sight path to one of your receiver towers while having a highly obstructed path between them, because of the elevation of the towers. They also can be further from each other than from the tower (e.g., on opposite sides of a circle surrounding the tower). Second, many Part 15 devices are designed specifically to cope with the hostile interference environment that is anticipated in the 902-928 MHz band (e.g. RF arc welders and plywood heaters). For example, AT&T's frequency hopping technology (used for both cordless telephones and wireless business telephone systems) automatically replaces frequencies on which collisions occur with new, randomly-selected frequencies (in accordance with 47 CFR §15.247). I have done extensive analysis and simulation of the effectiveness of this scheme, and have concluded that a fairly large number of hoppers can harmoniously coexist within a small area without any central control. Further, the frequency replacement mechanism provides some protection against the hoppers interfering with other Part 15 devices that use different formats (e.g., direct sequence systems).* As required by §15.247, the frequency hopping pattern is randomly selected upon initialization, so there are no special "synchronization frequencies." Presumably, the adjacent-channel interference and "poor frequency discrimination" you mention refer to the fact that practical IF filters have finite rolloff that allows some energy from the adjacent channels into the IF. To my knowledge, this is not peculiar to low-cost Part 15 devices, but rather exists in virtually every portable communications receiver (including cellular telephones). Adjacent-channel interference is not a major issue; 20 to 30 dB of adjacent channel isolation is perfectly adequate to prevent significant capacity degradation in a frequency-reuse system. This degree of isolation is readily available with low-cost, off-the-shelf ceramic filters.

You are correct that the processing gain built into most Part 15 direct sequence (DS) systems is not adequate to cope with a strong random interfering signal. However, DS systems designed for robustness in the 902-928 MHz band typically also have frequency agility, allowing them to move away from the

---

* Unfortunately, this mechanism will not protect Teletrac's system because the transmitted signal from the vehicle is of very short duration (on the order of 10 milliseconds) and broadband (so most of the energy falls outside the passband of the frequency hopping receiver). In addition, the signal received by the Part 15 device often will be quite weak due to the large path loss between the vehicle and the Part 15 device (both will typically be near ground level, so the path between them will be highly obstructed).

interference. Further, a well-chosen set of spreading codes (low or zero cross-correlation) will allow multiple DS units of the same system to share a band with little or no mutual interference.

Because of the above considerations, I disagree with your view that Part 15 interference will be self-limiting.

- You dispute my conclusions about the effect of the receiver threshold. I believe that this reflects an incomplete understanding of the analysis, so I will attempt to clarify. Any receiver (spread spectrum or otherwise) will have a "threshold" value of E_b/N_0 below which performance does not meet the objectives. If N_0 is constant (i.e., independent of bandwidth, which is the usual assumption), then as the message duration decreases (to increase capacity), E_b decreases proportionally. For a fixed bandwidth, if your receiver is operating above threshold, the rms time-of-arrival (TOA) estimation error varies as the inverse square root of E_b, and hence as the square root of the capacity. Since the rms TOA estimation error also varies as the inverse of bandwidth, you can compensate by increasing the bandwidth as the square root of the capacity increase, keeping the rms TOA estimation error constant as capacity is increased. This gives the familiar (and misleading) relationship that capacity can be quadrupled by doubling bandwidth. However, below threshold, the simulation results reported in Teletrac's Petition for Rule Making suggest that for Teletrac's receiver, the rms TOA estimation error varies as the **inverse squared** of the message duration (this is shown in the paper), so it increases as the **square** of "capacity." Hence, bandwidth must be increased fourfold to maintain a constant error when capacity is doubled.

  One might think that if your system is designed to operate above threshold by some margin, the "bandwidth squared" capacity increase holds. This is misleading, however, because the maximum capacity must be computed under some assumed set of system design parameters, including carrier-to-noise margins. If you presume to quadruple the maximum capacity by reducing message duration by a factor of four, you have reduced E_b/N_0, and hence your margin, by 6 dB, and you have a system with a different set of design parameters. This tradeoff is nothing new; in any multiple-access system for which performance must be characterized statistically (cellular, for example), the nominal capacity can be increased by reducing the performance margins. In other words, you can serve more subscribers by reducing the quality of service per subscriber (e.g., higher blocking probability, greater rate of dropped calls, etc.). Hence, the "bandwidth squared" capacity increase is simplistic and ignores a fundamental set of design tradeoffs.

Hopefully this clarifies your understanding of the points you raised. If any of this still is unclear I would be glad to discuss it further.

Regarding the interference tests, I feel confident in saying that interest in the tests is not limited to the cordless telephone industry, but rather includes representatives of a number of other Part 15 industries. While I understand your concerns about the potential for confusion in working with the Part 15 industry as a whole rather than with small sub-categories individually, I believe that the benefits of pooling our engineering resources and exchanging ideas outweigh the difficulties associated with the large number of participants. Equally important, the methodology, results, and conclusions will have the endorsement of a large cross-section of the industry and therefore will be more credible than a limited "special case" test. I disagree with your belief that such a representative experiment is necessarily time-consuming. I certainly am not proposing to test every Part 15 device in existence; that probably would be impractical. What I *do* suggest is that we develop an experiment that is reasonably representative of most types of expected interference. With the right program structure, this can be accomplished in a timely fashion. Moreover, it would seem most efficient to address all relevant aspects of the problem in parallel rather than serially.

Therefore, as a first step I propose a meeting of interested parties to plan the program. I envision this as a one-day session during which the program and schedule for the test will be agreed upon, including a list of participants and any necessary confidentiality arrangements. To facilitate this process, I have taken the liberty of drafting some notes outlining a "straw man" test plan (also enclosed) which can provide an initial focus for discussion at the meeting. Any comments on this draft prior to the meeting are also welcome.

I continue to believe that if we do not allow Part 15 interests other than cordless telephones to be involved in this, the results will necessarily be inconclusive and subject to challenge from those who are excluded. I therefore encourage you to reconsider your position and agree to participate in such a program in cooperation with ourselves and other Part 15 interests.

Finally, I would like to caution you regarding any inferences you might draw from your limited experience with Part 15 interference to date. While the penetration of Part 15 devices may be relatively low now, it is increasing, and we expect that trend to accelerate as manufacturers complete their designs and deploy products. Hence, the past is not a reliable predictor of the future in this case.

I look forward to meeting with you and other interested parties to discuss these tests.

Regards,

Jay E. Padgett
Chairman, TIA MPC
Consumer Radio Section

enclosures as above

cc: (w/enclosures)

Daniel L. Bart - TIA
Ralph A. Haller - Chief, FCC Private Radio Bureau
Steve Schear - Chairman, Part 15 Coalition
Eric J. Schimmel - TIA
Thomas P. Stanley - Chief Engineer, FCC